

Field Monitoring and Treatment of Herbicide Runoff from Highway Roadsides

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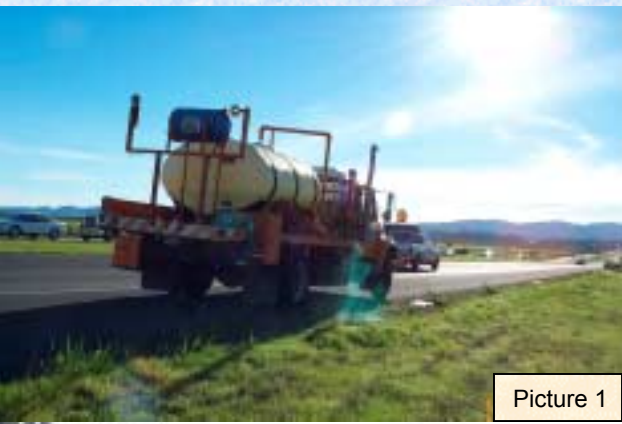


Introduction

To reduce weed growth along the highway roadside, herbicides are applied along many California highways by Caltrans (the California Transportation Department). This practice has been successful as a highway vegetation management program. However, Environmental regulatory agencies recently have focused attention on nonpoint sources of pollution such as highway runoff, and previous research has suggested that storm runoff water could be a source for surface water contamination. The public is concerned that herbicides sprayed by Caltrans could negatively impact the environment, in particular aquatic life. In order to address these concerns, this project is designed to determine whether best management practices currently employed by Caltrans adequately protect adjacent surface waters from herbicide runoff.

Herbicide Application

Two geographically separated sites were selected in the northern California. Different herbicides were applied in these two sites. Glyphosate, Oryzalin, and Isoxaben were applied along 1.3-meter wide roadside strip adjacent to the highway shoulder located on U.S. 101, at the north end of the Eel River Bridge, Rio Dell, California (Picture 2, Eel River sampling station). Oryzalin, Isoxaben, Transline, Diuron were applied at another site located at the north bank of highway 37 in Sonoma County, California (Picture 1, Tolay Creek sampling station). The herbicides were applied by a Caltrans' truck and the application rates ranged from 0.1 kg to 4.6 kg per ha.



Picture 1



Picture 2

Runoff Sampling

Storm water flowed through a 0.75 H flume and then into a catchment where the water was sampled by an automatic sampler through a suction strainer. A stilling well was used to detect the runoff level which was used to trigger the sampler and measure runoff volume. The automatic sampler (ISCO 6700) was powered by a 12-volt battery which was charged by a solar panel (Picture 3 and 4). A rain gauge (ISCO 674) and a bubbler flow module (ISCO 730), which measured the level in the stilling well, were connected to the sampler. The automatic sampler recorded rainfall, sampling time, runoff flow rate, and runoff volume (Figure 1).



Picture 3



Picture 4

Herbicide Attenuation by Vegetation and Mulch

As shown in Table 1, herbicides were highly attenuated when runoff water ran along the bio-strip roadside slope (Picture 5) during the first storm event.

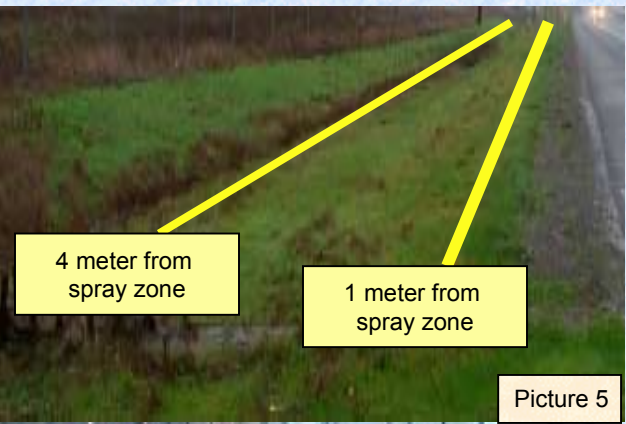
Table 1 Herbicides attenuation by bio-strip roadside

Distance from the spray zone	Oryzalin ug/L	Isoxaben ug/L	Diuron ug/L	Transline ug/L
1 meter	26.88	3.75	1.95	10.42
4 meter	4.16	1.61	0.71	5.32

A biomaterial treatment system (Picture 6), built downstream of the auto-sampler, consisted of a cell 6m x 1.5m x 0.3m filled with mulch followed by a wheat straw hay bale for filtration of mulch particles. As presented in Table 2, the herbicide concentration in the initial runoff sample from the outlet of the treatment cell was greatly reduced compared to those from the inlet. However, the event mean concentrations for the entire storm event were unchanged showing that the herbicide transport was retarded, reducing the peak concentrations at the out let.

Table 2 Herbicide concentration at inlet and outlet

Sampling point	Oryzalin ug/L	Isoxaben ug/L	Diuron ug/L	Transline ug/L
inlet	8.85	4.16	3.61	17.91
outlet	1.26	1.24	1.99	4.64



Picture 5



Picture 6

Figure 1 Rainfall, flow rate, runoff and sampling time for a typical storm event at Tolay Creek sampling station (2001-2002)

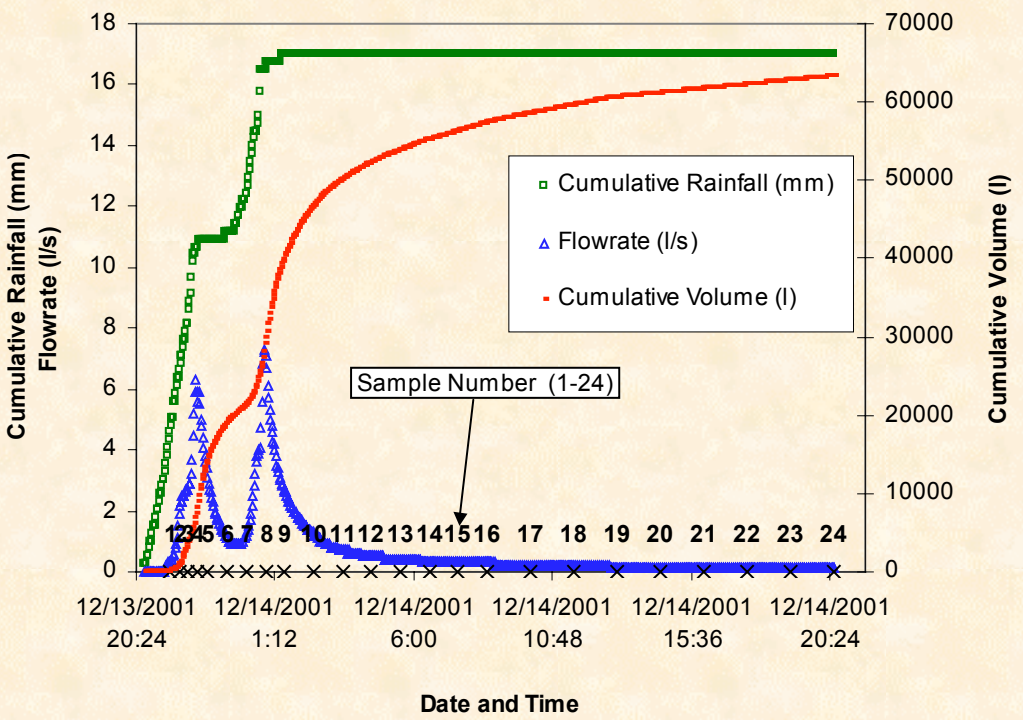
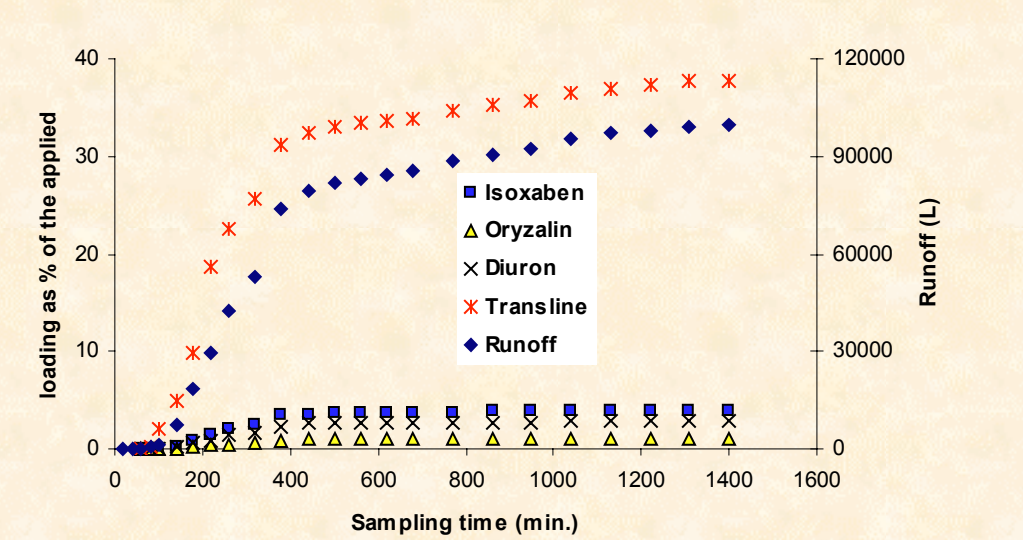


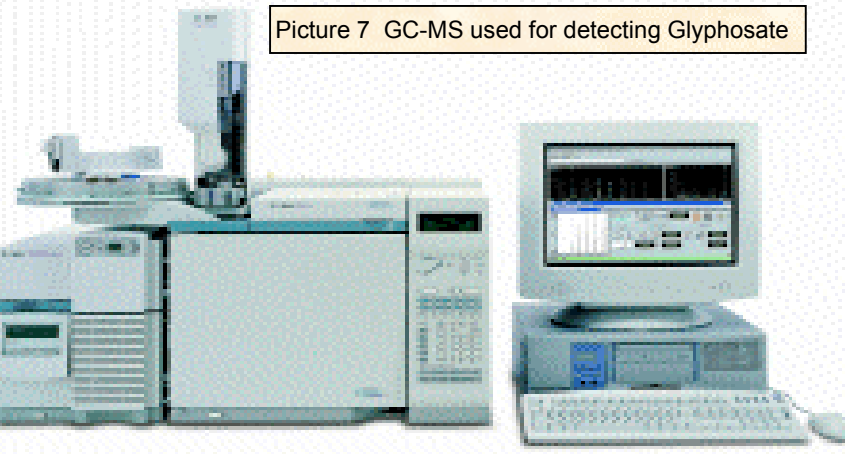
Figure 2 Herbicide loading as % of the applied vs. runoff at Tolay Creek sampling station (2001-2002)



As shown in Figure 2, the herbicide loading was highly related to runoff volume. The loading differences among the herbicides were mainly caused by the herbicide properties. Transline has a much higher loading in runoff compared to the others since it has a very high water solubility.

Herbicide Analysis in Lab

Runoff water were transported to the lab. Oryzalin, Isoxaben, Diuron, Transline were analyzed by HPLC, and Glyphosate by GC-MS (Picture 7).



Picture 7 GC-MS used for detecting Glyphosate

Table 3 Summary of herbicide EMC and loading as% of the applied from the two sampling stations (1999-2002)

Herbicides	EMC (ug/L)	Loading as % of the applied
Oryzalin	0.1 – 42.4	0.05-5.43
Isoxaben	0.1 – 14.4	0.12-15.02
Diuron	0.1 – 10.2	0.57-4.44
Transline	0.5 – 7.1	43.53
Glyphosate	0.1 –21.5	< 1.0

Summary

Herbicides were detected in runoff water from all storm events at both sites. The Event Mean Concentration (EMC) and loading percentage had large ranges among different herbicides at the two sampling locations for the past three years. Transline has a highest loading percentage among the five herbicides tested.

The Bio-strip along the highway roadside slope can significantly attenuate herbicide concentrations from storm runoff water. Herbicide concentrations were greatly reduced by mulch in the treatment cell, but only during the initial flush of runoff water.

Acknowledgments

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